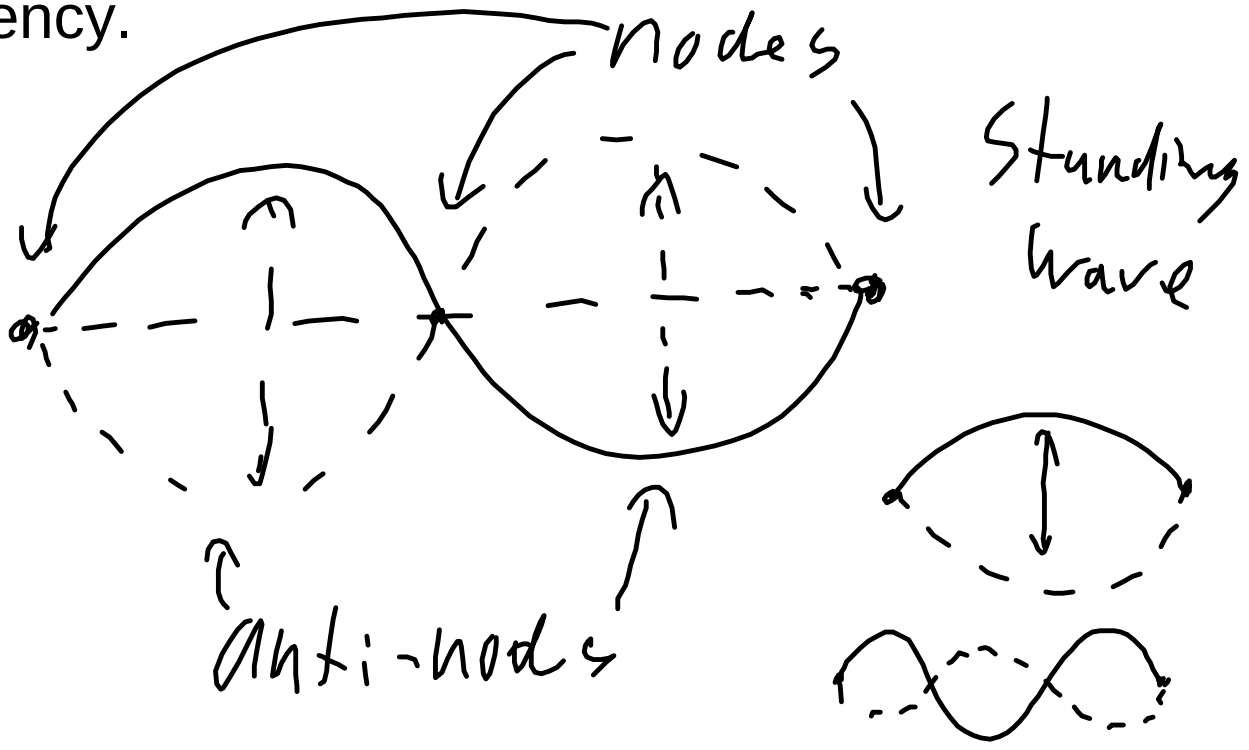
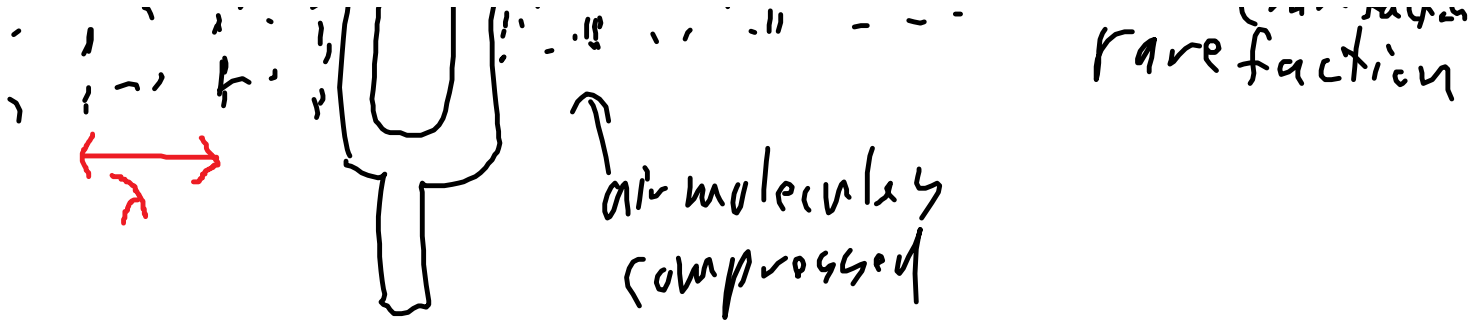
Standing Waves and Sound

Standing waves are produced when incident and reflected waves interfere to produce high amplitude waves that don't seem to move.
It happens if the frequencies are just right for the location.
This is an example of resonance - when an external force causes a oscillating system to vibrate at higher amplitudes at a preferred frequency.



Sound

Sound is vibrations you can hear.
humans hear from 20 to 20 000 Hz ish

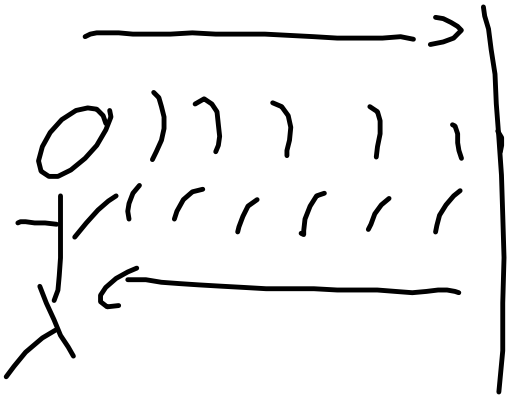


Frequency of sound is related to pitch.
Higher frequency = higher pitch

amplitude of the sound wave is related to the difference in pressure between the compression and rarefaction (P=F/A)

Speed of sound: v_s= 343 m/s in air at sea level at normal pressure and humidity but varies substantially with temperature, pressure, humidity.
sound moves at 1500 m/s in water
about 6000 m/s in steel

eg. You yell and hear your echo off a cliff wall 1.40 s later. How far is the wall?



$d = vt$

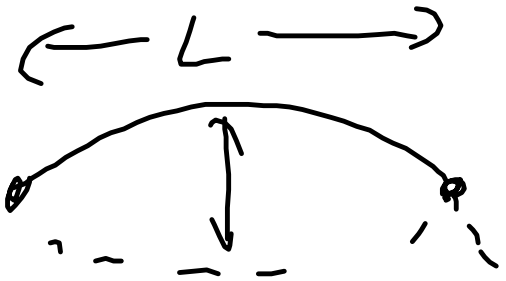
$d = 343\ m/s \left(\frac{1.4\ s}{2}\right)$

$d = 240\ m$

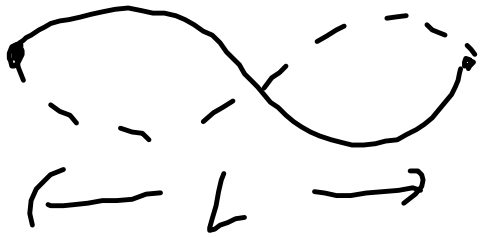
$d = 240\,m$

What frequencies resonate in a string? An open tube? A closed tube?

Standing wave is produced with nodes where the string is held and at the closed end of the tube and anti-nodes at the open end of the tube.



$L = \frac{\lambda}{2}$



$L = \lambda$

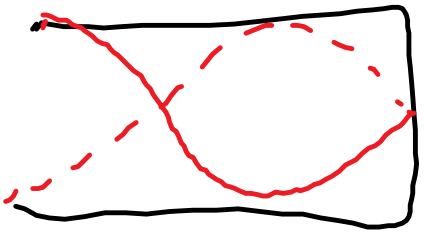
$L = \frac{3\lambda}{2}$

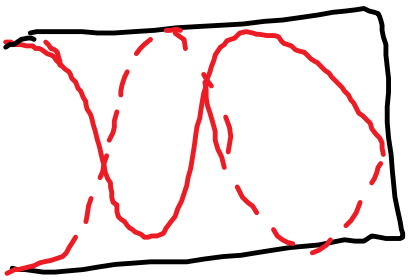
$L = \frac{N}{2}\lambda$ N = whole number 1, 2, 3...

This equation is valid for waves in strings

and open tubes (open at both ends).

How about a closed tube?





eg. The speed of a wave in a steel string is 2000 m/s with a length 1.0 m. What are the lowest frequency that resonates in the string?

What are the 2 overtones (next 2 freqencies).

eg. You hit a 392 Hz tuning fork and hold it over a closed tube that resonates (you hear an echo) when it is 21 cm long. What is the speed of sound in air in this room? (ignore the end correction - the anti-node is actually a little outside the tube)

p309Q1-4, p318 Q5-10
resonant spacing = $\lambda/2$
https://www.youtube.com/watch?v=BUREX8aFbMs
https://www.youtube.com/watch?v=sH7XSX10QkM
https://www.youtube.com/watch?v=6ai2QFxStxo
read the highest rated comment in the comments section, it is good.